

FORM PTO-1390 (Modified)
(REV 11-98)

U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

ATTORNEY'S DOCKET NUMBER

TRANSMITTAL LETTER TO THE UNITED STATES
DESIGNATED/ELECTED OFFICE (DO/EO/US)
CONCERNING A FILING UNDER 35 U.S.C. 371

112740-261

U.S. APPLICATION NO. (IF KNOWN, SEE 37 CFR

Unknown 09/913987

INTERNATIONAL APPLICATION NO.
PCT/DE00/00371INTERNATIONAL FILING DATE
08 February, 2000PRIORITY DATE CLAIMED
18 February 1999

TITLE OF INVENTION

NETWORK NODES WITH OPTICAL AND/DROP MODULES

APPLICANT(S) FOR DO/EO/US

Harald Bock et al.

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☒ This is an express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(1).
4. ☒ A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.
- ☒ A copy of the International Application as filed (35 U.S.C. 371 (c) (2))
 - a. ☒ is transmitted herewith (required only if not transmitted by the International Bureau).
 - b. ☐ has been transmitted by the International Bureau.
 - c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
- ☒ A translation of the International Application into English (35 U.S.C. 371(c)(2)).
- ☒ A copy of the International Search Report (PCT/ISA/210).
- ☒ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371 (c)(3))
 - a. ☒ are transmitted herewith (required only if not transmitted by the International Bureau).
 - b. ☐ have been transmitted by the International Bureau.
 - c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
 - d. ☐ have not been made and will not be made.
- ☒ A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
- ☒ An oath or declaration of the inventor(s) (35 U.S.C. 371 (c)(4)).
- ☒ A copy of the International Preliminary Examination Report (PCT/IPEA/409).
- ☐ A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371 (c)(5)).

Items 13 to 20 below concern document(s) or information included:

13. ☐ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
14. ☒ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
15. ☒ A **FIRST** preliminary amendment.
16. ☐ A **SECOND** or **SUBSEQUENT** preliminary amendment.
17. ☒ A substitute specification.
18. ☐ A change of power of attorney and/or address letter.
19. ☒ Certificate of Mailing by Express Mail
20. ☒ Other items or information:

Submission of Drawings Figures 1-4 on three sheets

U.S. APPLICATION NO. (IF KNOWN, SEE 37 CFR 1.51) 09/913987		INTERNATIONAL APPLICATION NO. PCT/DE00/00371		ATTORNEY'S DOCKET NUMBER 112740-261	
21. The following fees are submitted:				CALCULATIONS PTO USE ONLY	
BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)) :					
<input type="checkbox"/> Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO \$1,000.00					
<input checked="" type="checkbox"/> International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO \$860.00					
<input type="checkbox"/> International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO \$710.00					
<input type="checkbox"/> International preliminary examination fee paid to USPTO (37 CFR 1.482) but all claims did not satisfy provisions of PCT Article 33(1)-(4) \$690.00					
<input type="checkbox"/> International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(1)-(4) \$100.00					
ENTER APPROPRIATE BASIC FEE AMOUNT =				\$860.00	
Surcharge of \$130.00 for furnishing the oath or declaration later than <input type="checkbox"/> 20 <input type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492 (e)).				\$0.00	
CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE		
Total claims	4 - 20 =	0	x \$18.00	\$0.00	
Independent claims	2 - 3 =	0	x \$80.00	\$0.00	
Multiple Dependent Claims (check if applicable).			<input type="checkbox"/>	\$0.00	
TOTAL OF ABOVE CALCULATIONS =				\$860.00	
Reduction of 1/2 for filing by small entity, if applicable. Verified Small Entity Statement must also be filed (Note 37 CFR 1.9, 1.27, 1.28) (check if applicable).				<input type="checkbox"/>	\$0.00
SUBTOTAL =				\$860.00	
Processing fee of \$130.00 for furnishing the English translation later than <input type="checkbox"/> 20 <input type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492 (f)).				\$0.00	
TOTAL NATIONAL FEE =				\$860.00	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31) (check if applicable).				<input checked="" type="checkbox"/>	\$40.00
TOTAL FEES ENCLOSED =				\$900.00	
				Amount to be refunded	\$
				charged	\$
<input checked="" type="checkbox"/> A check in the amount of \$860.00 to cover the above fees is enclosed.					
<input type="checkbox"/> Please charge my Deposit Account No. _____ in the amount of _____ to cover the above fees. A duplicate copy of this sheet is enclosed.					
<input checked="" type="checkbox"/> The Commissioner is hereby authorized to charge any fees which may be required, or credit any overpayment to Deposit Account No. 02-1818 A duplicate copy of this sheet is enclosed.					
NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.					
SEND ALL CORRESPONDENCE TO:					
Thomas C. Basso (Reg. No. 46,541) Bell, Boyd & Lloyd LLC P.O. Box 1135 Chicago, Illinois 60690					
SIGNATURE Thomas C. Basso NAME 46,541 REGISTRATION NUMBER August 20, 2001 DATE					

BOX PCT

IN THE UNITED STATES ELECTED/DESIGNATED OFFICE
OF THE UNITED STATES PATENT AND TRADEMARK OFFICE
UNDER THE PATENT COOPERATION TREATY-CHAPTER II

5

PRELIMINARY AMENDMENT

APPLICANTS: Dr. Harald Bock et al. DOCKET NO: 112740-261
SERIAL NO: Unknown GROUP ART UNIT: Unknown
EXAMINER: Unknown
INTERNATIONAL APPLICATION NO: PCT/DE00/00371
INTERNATIONAL FILING DATE: 8 February 2000
INVENTION: NETWORK NODES WITH OPTICAL ADD/DROP MODULES

Assistant Commissioner for Patents,
Washington, D.C. 20231

Sir:

Please amend the above-identified International Application before entry into the
National stage before the U.S. Patent and Trademark Office under 35 U.S.C. §371 as follows:

In the Specification:

Please replace the Specification of the present application, including the Abstract,
with the following Substitute Specification:

SPECIFICATION

TITLE

NETWORK NODES WITH OPTICAL ADD/DROP MODULES

BACKGROUND OF THE INVENTION

Field of the Invention

The invention generally relates to a network node. More specifically, the present
invention relates to a network node with optical add/drop modules.

Description of the Prior Art

A network node for use in a ring network is generally disclosed in German Patent Document No. DE 19731494 C4. The ring network provided for transmitting data in the wavelength division multiplex method has a working device, a protection device and a number of network nodes with add/drop modules. The distinctive feature of this known ring network, the transmission capacity of which is to be utilized to an optimum extent, consists in using only a single protection channel which can be accessed by all terminals, i.e., being able to send data and to receive data.

As disclosed in European Patent Document No. EP 0 847 158 A2, a network node with optical add/drop modules for bidirectional networks is also known in which a separate module OADM1 and OADM2, respectively, is provided for each of the two directions of transmission, in which in each case an add function and a drop function is combined for the respective direction of transmission. The known arrangement is neither provided for a ring network nor does it contain a protection device.

As disclosed in European Patent Document No. EP 0 892 524 A2, a network node with optical add/drop modules in a unidirectional ring network that has a number of ring lines is also known. In the case of a "single point of failure" in the network, the signals are diverted via other links of another ring line which are not faulty.

It is also known as disclosed in European Patent Document No. EP 0 729 247 A2 to guarantee the transmission capacity in bidirectional ring networks, for example in the case of a disturbance, by transmitting on each fiberglass waveguide, in addition to the operating signal, a replacement signal of different wavelength. In the case of a disturbance, i.e., in the case of an interruption of the connection between two network elements, the operating signal between the network elements of the ring network affected by the failure of the connection is switched to the replacement signal, and thus to the second wavelength, thereby maintaining the full transmission capacity. The network elements provided are add/drop multiplexers which are arranged in parallel with existing optical interfaces at in each case additional optical interfaces. These additional interfaces operate in a different wavelength range in contrast to the existing optical interfaces. Operating signal and replacement signal of an optical transmitter are combined in a suitable manner by optical multiplexers at the output of each network element and transmitted to the receiving site by the respective optical

fiber waveguides. At the receiving site, an optical demultiplexer separates the two optical signals of different wavelengths and supplies them to the further processing stages.

In purely optical wavelength division multiplex networks, some of the optical connections will be purely of a static nature but some others will have short lifetimes. To optimally utilize the network capacities, there exists a need for automatically reconfigurable and purely optical add/drop multiplexers. In this regard, the reconstruction of existing systems may necessarily need to take place with continuing traffic, i.e., careful protection of the continuing traffic without optical "single point of failure" is necessarily required.

In addition, the ability to implement not only traffic links via a central hub-type network node but any point-to-point connections may necessarily be needed. A typical traffic pattern in future two-fiber ring networks will necessarily include a forward return connection in different fibers on the same link. In this regard, the corresponding protection connection leads via a different route in two fibers, thus providing for a reliable standby connection in the case of a fiber break.

Due to the minimization of production costs in metropolitan ring networks, great differences in level must be expected in the individual wavelength channels.

In this regard, the static add/drop multiplexers in purely optical wavelengths division multiplex rings will necessarily need to be expanded into dynamically remotely and configurable add/ drop multiplexers, thus an "in-service" expansion should be possible.

Static optical add/drop multiplexer network elements have only been on the market for a very short time (CAMBRIAN, CIENA, OSICOM, LUCENT, SIEMENS 04/99), where commercial remotely configurable systems are expected for the year 2000. The remote configurability of optical add/drop multiplexer modules has currently only been implemented by way of expensive optical circuit technology (i.e., wavelengths division multiplexers, demultiplexers and space division switching matrices).

However, no corresponding arrangements for setting up remotely configurable protected 1+1 connections have been reported although the use of fiber gratings in add/drop modules is described in US Patent No. 5,748,349.

An object of the present invention, therefore, relates to protecting the transmission of a WDM signal from an interruption of the line when, for example, modules are exchanged in a ring network.

SUMMARY OF THE INVENTION

Accordingly, the present invention is directed to a network node with optical add modules and drop modules which can provide an uninterrupted transmission of a signal between any two network nodes when a necessary change of one of the two modules in the ring network is made.

The circuit arrangement of the purely optical add/drop module of the present invention provides for modular expansion of static add/drop multiplexers in wavelengths division multiplex rings to form dynamically remotely configurable add/drop multiplexers. In this arrangement, a heterodyne crosstalk of < 50 dB can be achieved.

In contrast to the conventional arrangement of the components in add/drop multiplexers based on fiber gratings, circulators and/or 1:2 couplers on one board, the drop (i.e., circulator and grating) and add (i.e., 1:2 coupler) functions of the present invention are distributed over two separate boards.

As a result, bidirectional two-fiber traffic can be implemented without any “single point of failure”, e.g., electrical and/or optical 1+1 protection is fully supported. In this regard, the module can also be used for protected unidirectional traffic by external plugging.

Due to the distributed add/drop functionality on two boards (or groups of boards), a board (group of boards) can be exchanged after complete protection switching without interrupting the connection.

Due to the modularity (e.g., group of four tunable gratings) and the protection characteristics of the circuit arrangement of the present invention, continuous expansion of existing static add/drop multiplexers to “in-service” conversion associated with dynamic traffic patterns can be provided.

The module of the present invention can support a large number of channels (up to 128) and/or great differences in the individual channel levels.

An important aspect of the present invention relates to the circuit arrangement that can protect the optical path against a “single point of failure”, i.e., the separate arrangement of add and drop functions on two boards. For example, the present invention can include a circulator and tunable gratings for the drop process in addition to a 1:2 coupler for inserting new channels.

An additional dielectric filter, for example, as disclosed in US Patent No. 5,748,349 can be used for splitting the wavelengths and for increasing the heterodyne crosstalk to less than 55 dB.

Additional features and advantages of the present invention are described in, and will be apparent from, the Detailed Description of the Preferred Embodiment and the Drawings.

DESCRIPTION OF THE DRAWINGS

Fig. 1 diagrammatically shows a bidirectional ring network according to the prior art.

Fig. 2 diagrammatically shows an embodiment of a remotely configurable optical add/drop multiplexer for bidirectional traffic of the present invention.

Fig. 3 diagrammatically shows another embodiment of a remotely configurable optical add/drop multiplexer for bidirectional traffic of the present invention.

Fig. 4 diagrammatically shows an embodiment of a remotely configurable optical add/drop multiplexer for unidirectional traffic of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

In an embodiment, the configuration of a remotely configurable optical add/drop multiplexer for bidirectional traffic of the present invention is shown in Figure 2. As previously discussed, Figure 1 shows a bidirectional ring network according to the prior art.

Figure 3 shows another example of the optical add/drop multiplexer for bidirectional traffic of the present invention.

In an embodiment, a drop wavelength of each of the four gratings (filters) can be tuned by piezoelectric adjusting elements (such as, 200 GHz max. or HIGHWAVE). This makes it possible to flexibly drive two wavelength channels with one grating (crosstalk < 30 dB). The wavelength filters can be typically constructed of dielectric layers to enhance heterodyne crosstalk (i.e., < 25 dB crosstalk). The 4:1 coupler can be replaced by a wavelength filter.

To achieve a maximum of flexibility for future developments, the add/drop function can be separated from the routing function of the optical cross connect card (OCC). It should be appreciated that the OCC card is optional.

As previously discussed, Figure 3 shows a working and protection path for reconfigurable OADM. In this regard, it should be appreciated that an important aspect of the present invention is the OADM-R board(s) as shown in Figure 3.

For example, the circuit arrangement of the optical components on the two OADM-R boards and the resultant logical separation of the add/drop functions. By separating the drop function (circulator and four gratings in this case) and the add function (1:2 coupler) on two different boards, any "single point of failure" can be prevented in the case of 1:1 protection.

5 It should be appreciated that this logical separation is not provided when a second circulator is used.

Combining two OADM-R boards (board means module; or on two groups of boards instead of on two boards) also provides for an evolution from rigid to dynamically reconfigurable traffic relationships as compared to existing systems which usually use groups of four wavelengths that can be supplemented by one "dynamic group" during continued operation.

Further, the present invention can include an additional wavelength filter. The additional wavelength filter can result in a suppression of the heterodyne crosstalk by over 55 dB. This value can enable modules to be used in systems with 128 channels and/or with great differences in the individual channel levels.

15 It should be appreciated that Applicants believe that commercially available add/drop modules do not provide for "in-service" expansion and further require group prefilters to be used in order to achieve cost-reducing modularity. To achieve a protected connection, commercially available modules must necessarily include two 2x2 switches for each wavelength.

20 As shown in Figure 4, the OADM-R module can also be used in unidirectional two-fiber ring networks. It should be appreciated that this does not require any change in the hardware configuration where the required changes can be implemented by external plug-in fiber connections for use in unidirectional two-fiber ring networks.

25 It should be understood that various changes and modifications to the presently preferred embodiments described herein will be apparent to those skilled in the art. Such changes and modifications can be made without departing from the spirit and scope of the present invention and without diminishing its attended advantages. It is therefore intended that such changes and modifications be covered by the hereafter appended claims.

ABSTRACT OF THE DISCLOSURE

The present invention relates to a network node that includes optical add/drop modules such that a module can be exchanged without disruption of the connections.

In the claims:

On amended page 6, cancel line 1, and substitute the following left-hand justified heading therefor:

We Claim as Our Invention:

5 Please cancel claims 1-3, without prejudice, and substitute the following claims therefor:

4. A network node having optical add modules and drop modules for a bidirectional ring network that has a working connection and a protection connection to other network nodes, comprising:

10 a first drop module and a first add module positioned on a protection module for bidirectional protection connection; and

a second drop module and a second add module positioned on a working module for bidirectional working connection, wherein the second drop module and the first add module are positioned in series with respect to a second fiber ring and wherein the first drop module and the second add module are positioned in series with respect to a first fiber ring.

15 5. The network node as claimed in Claim 4, wherein the first drop and add modules of the protection module and the second drop and add modules of the working module each have a line input and a line output such that the first drop and add modules and the second drop and add modules are each insertable in the first or second fiber rings.

20 6. A network node having optical add modules and drop modules for a unidirectional ring network which has a working connection and a protection connection to other network nodes, comprising:

a first drop module and a first add module positioned on a protection module for protection connection; and

25 a second drop module and a second add module positioned on a working module for working connection, wherein the first drop module and the first add module are inserted in series in a second fiber ring and the second drop module and the second add module are inserted in series in a first fiber ring.

7. The network node as claimed in Claim 6, wherein the first drop and add modules and the second drop and add modules each have a line input and a line output such that the first drop and add modules and the second drop and add modules are insertable in series into the first fiber ring or the second fiber ring.

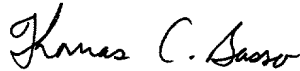
REMARKS

The present amendment makes editorial changes and corrects typographical errors in the specification, which includes the Abstract, in order to conform the specification to the requirements of United States Patent Practice. No new matter is added thereby. Attached hereto is a marked-up version of the changes made to the specification by the present amendment. The attached page is captioned "Version With Markings To Show Changes Made".

In addition, the present amendment cancels original claims 1-3 in favor of new claims 4-7. Claims 4-7 have been presented solely because the revisions by red-lining and underlining which would have been necessary in claims 1-3 in order to present those claims in accordance with preferred United States Patent Practice would have been too extensive, and thus would have been too burdensome. The present amendment is intended for clarification purposes only and not for substantial reasons related to patentability pursuant to 35 USC §§103, 102, 103 or 112. Indeed, the cancellation of claims 1-3 does not constitute an intent on the part of the Applicants to surrender any of the subject matter of claims 1-3.

Early consideration on the merits is respectfully requested.

Respectfully submitted,



(Reg. No. 46,541)

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(312) 807-4310
Attorneys for Applicants

VERSIONS WITH MARKINGS TO SHOW CHANGES MADE

In The Specification:

The Specification of the present application, including the Abstract, has been amended as follows:

Description

~~Network nodes with optical add/drop modules~~

SPECIFICATION

TITLE

NETWORK NODES WITH OPTICAL ADD/DROP MODULES

BACKGROUND OF THE INVENTION

~~The invention~~

Field of the Invention

The invention generally relates to a network node in accordance with the features and the preambles of claims 1 and 2. More specifically, the present invention relates to a network node with optical add/drop modules.

Description of the Prior Art

~~Such a~~ A network node for use in a ring network is ~~basically known from~~ generally disclosed in German Patent Document No. DE 19731494 C4. The ring network provided for transmitting data in the wavelength division multiplex method has a working device, a protection device and a number of network nodes with add/drop modules. The distinctive feature of this known ring network, the transmission capacity of which is to be utilized to an optimum extent, consists in using only a single protection channel which can be accessed by all terminals, i.e., being able to send data and to receive data.

~~From~~ As disclosed in European Patent Document No. EP 0 847 158 A2, a network node with optical add/drop modules for bidirectional networks is also known in which a separate module OADM1 and OADM2, respectively, is provided for each of the two directions of transmission, in which in each case an add function and a drop function is combined for the respective direction of transmission. The known arrangement is neither provided for a ring network nor does it contain a protection device.

From As disclosed in European Patent Document No. EP 0 892 524 A2, a network node with optical add/drop modules in a unidirectional ring network ~~having that has~~ a number of ring lines is also known. In the case of a "single point of failure" in the network, the signals are diverted via other links of another ring line which are not faulty.

5 ~~Finally, is it known from~~ It is also known as disclosed in European Patent Document No. EP 0 729 247 A2 to guarantee the transmission capacity in bidirectional ring networks, for example in the case of a disturbance, by transmitting on each fiberglass waveguide, in addition to the operating signal, a replacement signal of different wavelength. In the case of a disturbance, i.e., in the case of an interruption of the connection between two network
10 elements, the operating signal between the network elements of the ring network affected by the failure of the connection is switched to the replacement signal, and thus to the second wavelength, thereby maintaining the full transmission capacity. The network elements provided are add/drop multiplexers which are arranged in parallel with existing optical interfaces at in each case additional optical interfaces. These additional interfaces operate in a different wavelength range in contrast to the existing optical interfaces. Operating signal and replacement signal of an optical transmitter are combined in a suitable manner by optical multiplexers at the output of each network element and transmitted to the receiving site by the respective optical fiber waveguides. At the receiving site, an optical demultiplexer separates the two optical signals of different wavelengths and supplies them to the further
15 processing stages.

In purely optical wavelength division multiplex networks, some of the optical connections will be purely of a static nature but some others will have short lifetimes. To optimally utilize the network capacities, ~~therefore, concepts~~ there exists a need for automatically reconfigurable and purely optical add/drop multiplexers ~~will be required in the future. The.~~ In this regard, the reconstruction of existing systems ~~should~~ may necessarily need to take place with continuing traffic, i.e., careful protection of the continuing traffic without optical "single point of failure" is necessarily required.

In addition, ~~it should be possible~~ the ability to implement not only traffic links via a central hub-type network node but any point-to-point connections, ~~see Figure 1~~ may necessarily be needed. A typical traffic pattern in future two-fiber ring networks will ~~be the setting up of~~ necessarily include a forward return connection in different fibers on the same link. ~~The~~ In this regard, the corresponding protection connection leads via a different route

in two fibers ~~and provides~~, thus providing for a reliable standby connection in the case of a fiber break.

Due to the minimization of production costs in metropolitan ring networks, great differences in level must be expected in the individual wavelength channels.

5 ~~The hitherto~~ In this regard, the static add/drop multiplexers in purely optical wavelengths division multiplex rings ~~are~~ will necessarily need to be expanded into dynamically remotely and configurable add/ drop multiplexers. ~~An, thus an~~ “in-service” expansion should be possible.

10 Static optical add/drop multiplexer network elements have only been on the market for a very short time (CAMBRIAN, CIENA, OSICOM, LUCENT, SIEMENS 04/99), where commercial remotely configurable systems are expected for the year 2000. The remote configurability of optical add/drop multiplexer modules has currently only been implemented by ~~means way~~ way of expensive optical circuit technology ~~((i.e.,~~ wavelengths division multiplexers ~~and,~~ demultiplexers, and space division switching matrices).

15 ~~In the literature~~ However, no corresponding arrangements for setting up remotely configurable protected 1+1 connections ~~are~~ have been reported ~~and~~ although the ~~basic~~ use of fiber gratings in add/drop modules is described in US ~~patent No. 5,748,349. Patent No. 5,748,349.~~

20 ~~Figure 1 shows a bidirectional ring network according to the prior art.~~

~~The~~ An object of the present invention ~~consists in ensuring a protected, therefore,~~ relates to protecting the transmission of a WDM signal ~~in the case of~~ from an interruption of the line ~~and~~ when, for example, modules are exchanged in a ring network.

25 ~~The problems described above are solved by network nodes constructed in accordance with claim 1 and claim 2. An advantageous further development of the invention is specified in claim 3.~~

SUMMARY OF THE INVENTION

30 ~~Using a network node configured in this manner results in the special advantage that in the case of a necessary exchange~~ Accordingly, the present invention is directed to a network node with optical add modules and drop modules which can provide an uninterrupted transmission of a signal between any two network nodes when a necessary change of one of the two modules in the ring network, ~~the transmission of a signal between any two network nodes is not interrupted, is made.~~

The circuit arrangement of the purely optical add/drop module ~~explained in greater detail in the attachment of the present invention~~ provides for modular expansion of static add/drop multiplexers in wavelengths division multiplex rings to form dynamically remotely configurable add/drop multiplexers. In this arrangement, a heterodyne crosstalk of ~~<50 dB~~ is 50 dB can be achieved.

In contrast to the conventional arrangement of the components in add/drop multiplexers based on fiber gratings, circulators and/or 1:2 couplers on one board, the ~~functions drop (circulator + drop (i.e., circulator and grating) and add ((i.e., 1:2 coupler)~~ functions of the present invention are distributed over two separate boards ~~in this case~~.

As a result, bidirectional two-fiber traffic can be implemented without any “single point of failure”, ~~i.e. e.g.,~~ electrical and/or optical 1+1 protection is fully supported. ~~In this regard,~~ the module can also be used for protected unidirectional traffic by external plugging).

Due to the distributed add/drop functionality on two boards (or groups of boards), a board (group of boards) can be exchanged after complete protection switching without interrupting the connection.

Due to the modularity (e.g., group of four tunable gratings) and the protection characteristics of the circuit arrangement of the present invention, continuous expansion of existing static add/drop multiplexers to “in-service” conversion ~~to associated with~~ dynamic traffic patterns ~~is ensured.~~ can be provided.

~~This module supports high numbers~~ The module of the present invention can support a large number of channels (up to 128) and/or great differences in the individual channel levels.

~~The essential inventive step lies in~~ An important aspect of the present invention relates to the circuit arrangement for protecting that can protect the optical path against a “single point of failure”, i.e., the separate arrangement of add and drop functions on two boards. For example, the present invention can include a circulator and tunable gratings for the drop process on the one hand, in addition to a 1:2 coupler for inserting new channels on the other hand.

An additional dielectric filter ~~(US patent No. 5,748,349)~~ is, for example, as disclosed in US Patent No. 5,748,349 can be used for splitting the wavelengths and for increasing the heterodyne crosstalk to less than 55 dB.

Exemplary embodiments of the invention will be explained in greater detail with reference to figures. Additional features and advantages of the present invention are described in, and will be apparent from, the Detailed Description of the Preferred Embodiment and the Drawings.

DESCRIPTION OF THE DRAWINGS

Fig. 1 diagrammatically shows a bidirectional ring network according to the prior art.

~~The configuration~~ Fig. 2 diagrammatically shows an embodiment of a remotely configurable optical add/drop multiplexer for bidirectional traffic ~~(as in Figure 1)~~ of the present invention.

Fig. 3 diagrammatically shows another embodiment of a remotely configurable optical add/drop multiplexer for bidirectional traffic of the present invention.

Fig. 4 diagrammatically shows an embodiment of a remotely configurable optical add/drop multiplexer for unidirectional traffic of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

In an embodiment, the configuration of a remotely configurable optical add/drop multiplexer for bidirectional traffic of the present invention is shown in Figure 2. ~~Figure 3 shows a more detailed example. A~~ As previously discussed, Figure 1 shows a bidirectional ring network according to the prior art. Figure 3 shows another example of the optical add/drop multiplexer for bidirectional traffic of the present invention.

In an embodiment, a drop wavelength of each of the four gratings (filters) can be tuned by piezoelectric adjusting elements ~~(currently~~ such as, 200 GHz max., or HIGHWAVE). This makes it possible to flexibly drive typically two wavelength channels with one grating (crosstalk ~~<30 dB~~ 30 dB). The wavelength filters ~~are~~ can be typically constructed of dielectric layers ~~(<25 dB~~ to enhance heterodyne crosstalk (i.e., <25 dB crosstalk). The 4:1 coupler can be replaced by a wavelength filter.

To achieve a maximum of flexibility for future developments, the add/drop function ~~was~~ can be separated from the routing function of the optical cross connect card (OCC). It should be appreciated that the OCC card is optional.

As previously discussed, Figure 3 ÷ shows a working and protection path for reconfigurable OADM. In this regard, it should be appreciated that an important aspect of the present ~~(optical add/drop multiplexer) nodes.~~

~~The central point of the~~ invention is the OADM-R board(s) as shown in Figure 3.÷

~~1. the special~~ For example, the circuit arrangement of the optical components on the two ~~OADM-R~~ OADM-R boards and the resultant logical separation of the add/drop functions.

By separating the drop function (circulator and four gratings in this case) and the add function (1:2 coupler) on two different boards, any “single point of failure” ~~is~~ can be prevented in the case of 1:1 protection. It should be appreciated that this logical separation is not ~~given~~ provided when a second circulator is used).

Combining two OADM-R boards (board =means module; or on two groups of boards instead of on two boards) also provides for an evolution from rigid to dynamically reconfigurable traffic relationships ÷ as compared to existing systems which usually use groups of four wavelengths ~~and that~~ can be supplemented by one “dynamic group” during continued operation.

~~2. Additional wavelength filter: the~~ Further, the present invention can include an additional wavelength filter ~~results~~. The additional wavelength filter can result in a suppression of the heterodyne crosstalk by over 55 dB. This value ~~enables~~ can enable modules to be used in systems with 128 channels and/or with great differences in the individual channel levels.

~~The~~ It should be appreciated that Applicants believe that commercially available add/drop ~~does~~ modules do not provide for “in-service” expansion and ~~requires~~ further require group prefilters to be used in order to achieve cost-reducing modularity. To achieve a protected connection, commercially available modules must necessarily include two 2x2 switches ~~must be provided~~ for each wavelength.

~~The~~ As shown in Figure 4, the OADM-R module can also be used in unidirectional two-fiber ~~rings, see Figure 4. This ring networks.~~ It should be appreciated that this does not require any change in the hardware configuration ~~and where~~ the required changes can be implemented by external plug-in fiber connections for use in unidirectional two-fiber ring networks.

It should be understood that various changes and modifications to the presently preferred embodiments described herein will be apparent to those skilled in the art. Such changes and modifications can be made without departing from the spirit and scope of the

ABSTRACT OF THE DISCLOSURE

The present invention relates to a network node that includes optical add/drop modules such that a module can be exchanged without disruption of the connections.

Description

3/ppts

Network nodes with optical add/drop modules

5 In purely optical wavelength division multiplex networks, some of the optical connections will be purely of a static nature but some others will have short lifetimes. To optimally utilize the network capacities, therefore, concepts for automatically reconfigurable purely optical add/drop multiplexers will be required in the future. The reconstruction of existing systems should take place with continuing traffic, i.e. careful protection of the continuing traffic without optical "single point of failure" is required.

In addition, it should be possible to implement not only traffic links via a central hub-type network node but any point-to-point connections, see Figure 1. A typical traffic pattern in future two-fiber ring networks will be the setting up of a forward/return connection in different fibers on the same link. The corresponding protection connection leads via a different link in two fibers and provides for a reliable standby connection in the case of a fiber break.

Due to the minimization of production costs in metropolitan ring networks, great differences in level must be expected in the individual wavelength channels.

The hitherto static add/drop multiplexers in purely optical wavelength division multiplex rings are to be expanded into dynamically remotely configurable add/drop multiplexers. An "in-service" expansion should be possible.

signal of different wavelength. In the case of a disturbance, i.e. in the case of an interruption of the connection between two network elements, the operating signal between the network elements of the ring network
5 affected by the failure of the connection is switched to the replacement signal, and thus to the second wavelength, maintaining the full transmission capacity. The network elements provided are add/drop multiplexers which are arranged in parallel with existing optical
10 interfaces at in each case additional optical interfaces. These additional interfaces operate in a different wavelength range in contrast to the existing optical interfaces. Operating signal and replacement signal of an optical transmitter are combined in a
15 suitable manner by optical multiplexers at the output of each network element and transmitted to the receiving site by the respective optical fiber waveguides. At the receiving site, an optical demultiplexer separates the two optical signals of different wavelengths and
20 supplies them to the further processing stages.

In purely optical wavelength division multiplex networks, some of the optical connections will be purely of a static nature but some others will have short
25 lifetimes. To optimally utilize the network capacities, therefore, concepts for automatically reconfigurable purely optical add/drop multiplexers will be required in the future. The reconstruction of existing systems should take place with continuing traffic, i.e. careful
30 protection of the continuing traffic without optical "single point of failure" is required.

In addition, it should be possible to implement not only traffic links via a central hub-type network node but
35 any point-to-point connections, see Figure 1. A typical traffic pattern in future two-fiber ring networks will be the setting up of a forward return connection in different fibers on the same link. The corresponding

protection connection leads via a different route in two fibers and provides for a reliable standby connection in the case of a fiber break.

- 5 Due to the minimization of production costs in metropolitan ring networks, great differences in level must be expected in the individual wavelength channels.

10 The hitherto static add/drop multiplexers in purely optical wavelengths division multiplex rings are to be expanded into dynamically remotely configurable add/drop multiplexers. An "in-service" expansion should be possible.

15 Static optical add/drop multiplexer network elements have only been on the market for a very short time (CAMBRIAN, CIENA, OSICOM, LUCENT, SIEMENS 04/99), commercial remotely configurable systems are expected for the year 2000. The remote configurability of
20 optical add/drop multiplexer modules has currently only been implemented by means of expensive optical circuit technology (wavelengths division multiplexers and demultiplexers, space division switching matrices).

25 In the literature, no corresponding arrangements for setting up remotely configurable protected 1+1 connections are reported and the basic use of fiber gratings in add/drop modules is described in US patent No. 5,748,349.

30

Figure 1 shows a bidirectional ring network according to the prior art.

35 The object of the present invention consists in ensuring a protected transmission of a WDM signal in the case of an interruption of the line and when modules are exchanged in a ring network.

The problems described above are solved by network nodes constructed in accordance with claim 1 and claim 2. An advantageous further development of the invention is specified in claim 3.

5

Using a network node configured in this manner results in the special advantage that in the case of a necessary exchange of one of the two modules in the ring network, the transmission of a signal between any
10 two network nodes is not interrupted.

The circuit arrangement of the purely optical add/drop module explained in greater detail in the attachment provides for modular expansion of static add/drop
15 multiplexers in wavelengths division multiplex rings to form dynamically remotely configurable add/drop multiplexers. In this arrangement, a heterodyne crosstalk of <50 dB is achieved.

20 In contrast to the conventional arrangement of the components in add/drop multiplexers based on fiber gratings, circulators and/or 1:2 couplers on one board, the functions drop (circulator + grating) and add (1:2 coupler) are distributed over two separate boards in
25 this case.

As a result, bidirectional two-fiber traffic can be implemented without any "single point of failure", i.e. electrical and/or optical 1+1 protection is fully supported (the module can also be used for protected
30 unidirectional traffic by external plugging). Due to the distributed add/drop functionality on two boards (or groups of boards), a board (group of boards)

can be exchanged after complete protection switching without interrupting the connection.

5 Due to the modularity (e.g. group of four tunable gratings) and the protection characteristics of the circuit arrangement, continuous expansion of existing static add/drop multiplexers to "in-service" conversion to dynamic traffic patterns is ensured.

10 This module supports high numbers of channels (up to 128) and/or great differences in the individual channel levels.

15 The essential inventive step lies in the circuit arrangement for protecting the optical path against a "single point of failure", i.e. the separate arrangement of add and drop functions on two boards: circulator and tunable gratings for the drop process on the one hand, a 1:2 coupler for inserting new channels
20 on the other hand.

An additional dielectric filter (US patent No. 5,748,349) is used for splitting the wavelengths and for increasing the heterodyne crosstalk to less
25 than 55 dB.

Exemplary embodiments of the invention will be explained in greater detail with reference to figures.

30 The configuration of a remotely configurable optical add/drop multiplexer for bidirectional traffic (as in Figure 1) is shown in Figure 2. Figure 3 shows a more detailed example. A drop wavelength of each of the four gratings (filters) can be tuned by piezoelectric
35 adjusting elements (currently 200 GHz max., or HIGHWAVE). This makes it possible to flexibly drive typically two wavelength channels with one grating

- 3a -

(crosstalk < 30 dB). The wavelength filters are typically

○

[illegible]

constructed of dielectric layers (<25 dB crosstalk).
The 4:1 coupler can be replaced by a wavelength filter.

To achieve a maximum of flexibility for future
5 developments the add/drop function was separated from
the routing function of the optical cross connect card
(OCC), the OCC card is optional.

Figure 3: working and protection path for
10 reconfigurable OADM (optical add/drop multiplexer)
nodes.

The central point of the invention is the OADM-R board:

15 1. the special circuit arrangement of the optical
components on the two OADMR boards and the resultant
logical separation of the add/drop functions.

By separating the drop function (circulator and four
20 gratings in this case) and the add function (1:2
coupler) on two different boards, any "single point of
failure" is prevented in the case of 1:1 protection
(this logical separation is not given when a second
circulator is used).

25 Combining two OADM-R boards (board = module; or on two
groups of boards instead of on two boards) also
provides for an evolution from rigid to dynamically
reconfigurable traffic relationships: existing systems
30 usually use groups of four wavelengths and can be
supplemented by one "dynamic group" during continued
operation.

35 2. Additional wavelength filter: the additional
wavelength filter results in a suppression of the
heterodyne crosstalk by over 55 dB. This value enables

modules to be used in systems with 128 channels and/or with great differences in the individual channel levels.

- 5 The commercially available add/drop does not provide for "in-service" expansion and requires group prefilters to be used in order to achieve cost-reducing modularity. To achieve a protected connection, two 2x2 switches must be provided for each wavelength.

10

The OADM-R module can also be used in unidirectional two-fiber rings, see Figure 4. This does not require any change in the hardware configuration and the required changes can be implemented by external plug-in

15

fiber connections.

Approved for Release by NSA on 08-26-2013 pursuant to E.O. 13526

Patent claims

1. A network node with optical add modules (ADD_i) and drop modules ($DROP_i$) ($i > 1$) for a bidirectional ring network, which has a working connection (line east) and a protection connection (line west) with in each case a first and a second optical fiber ring (R_1 , R_2) to other network nodes, characterized in that a first drop module ($DROP_1$) and a first add module (ADD_1) for the bidirectional protection connection (line west) are arranged on a protection module/group of boards (OADM- R_1) and in that a second drop module ($DROP_2$) and a second add module (ADD_2) for the bidirectional working connection (line east) are arranged on a working module/group of boards (OADM- R_2), in that the second drop module ($DROP_2$) and the first add module (ADD_1) are arranged serially in the second fiber ring (R_2) and the first drop module ($DROP_1$) and the second add module (ADD_2) are arranged serially in the first fiber ring (R_1).
2. The network node with optical add modules (ADD_i) and drop modules ($DROP_i$) ($i > 1$) for a unidirectional ring network with a first and a second optical fiber ring (R_1 , R_2), which has a working connection and a protection connection to other network nodes, characterized in that a first drop module ($DROP_1$) and a first add module (ADD_1) for the protection connection are arranged on a protection module/group of boards (OADM- R_1) and a second drop module ($DROP_2$) and a second add module (ADD_2) for the working connection are arranged on a working module/group of boards (OADM- R_2) and are connected in such a manner that the first drop module ($DROP_1$) and the first add module (ADD_1) are inserted in series in the second fiber ring (R_2) and the

second drop module (DROP₂) and the second add module (ADD₂) are inserted in series in the first fiber ring (R1).

- 5 3. The network node as claimed in claim 1 or 2,
characterized in that the drop modules (DROP₁, DROP₂)
and the add modules (ADD₁, ADD₂) of the protection
module/group of boards (OADM-R1) and of the working
10 module/group of boards (OADM-R2) in each case have a
line input and a line output so that, in the case of
bidirectional ring networks, the drop modules (DROP₁)
and the add modules (ADD₁) of the protection
module/group of boards (OADM-R1) and, respectively, the
15 drop modules (DROP₂) and the add modules (ADD₂) of the
working module/group of boards (OADM-R2) can in each
case be inserted into different fiber rings (R1, R2)
and that, in the case of unidirectional ring networks,
the first drop module (DROP₁) and the first add module
(ADD₁) of the protection module/group of boards (OADM-
20 R1) and the second drop module (DROP₂) and the second
add module (ADD₂) of the working module/group of boards
(OADM-R2) can in each case be inserted in series into a
fiber ring (R1, R2).

1/3

FIG 1

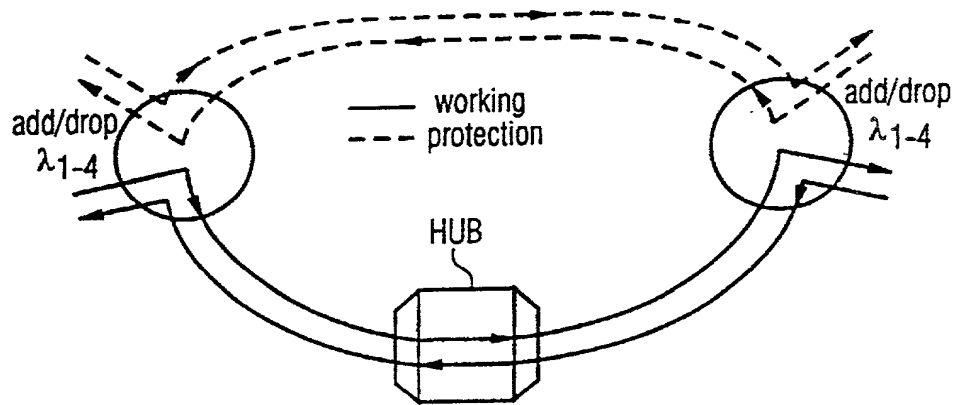
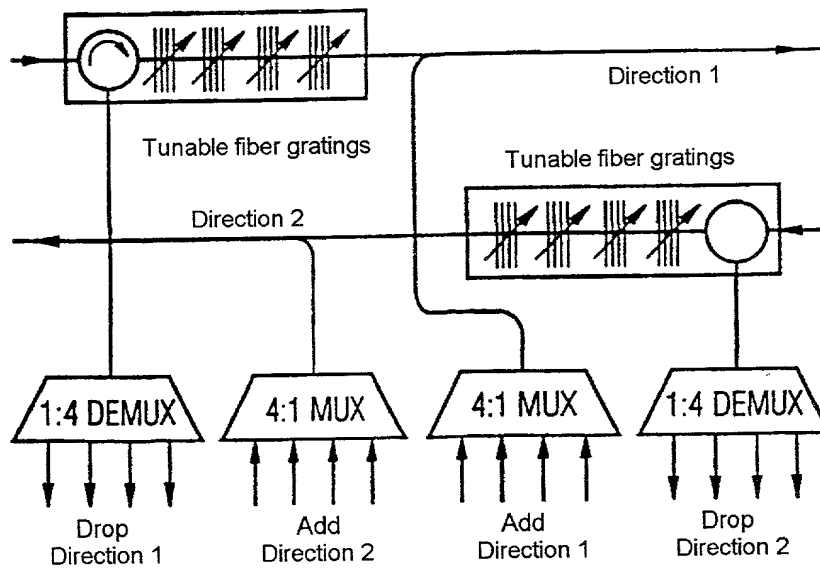


FIG 2



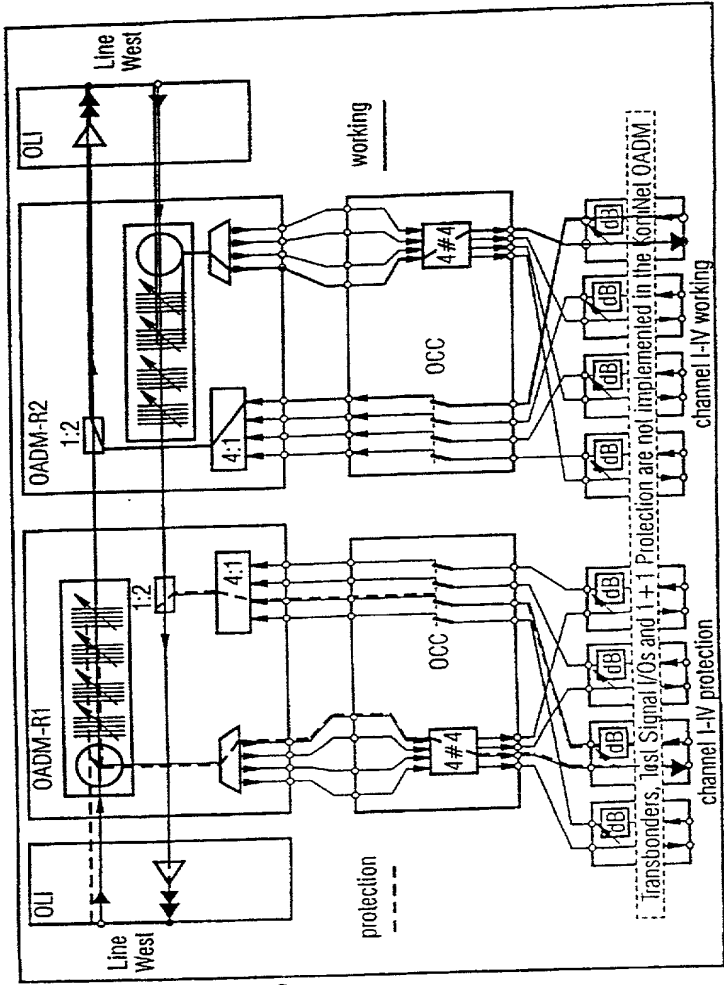


FIG 3

FIG 3

3/3

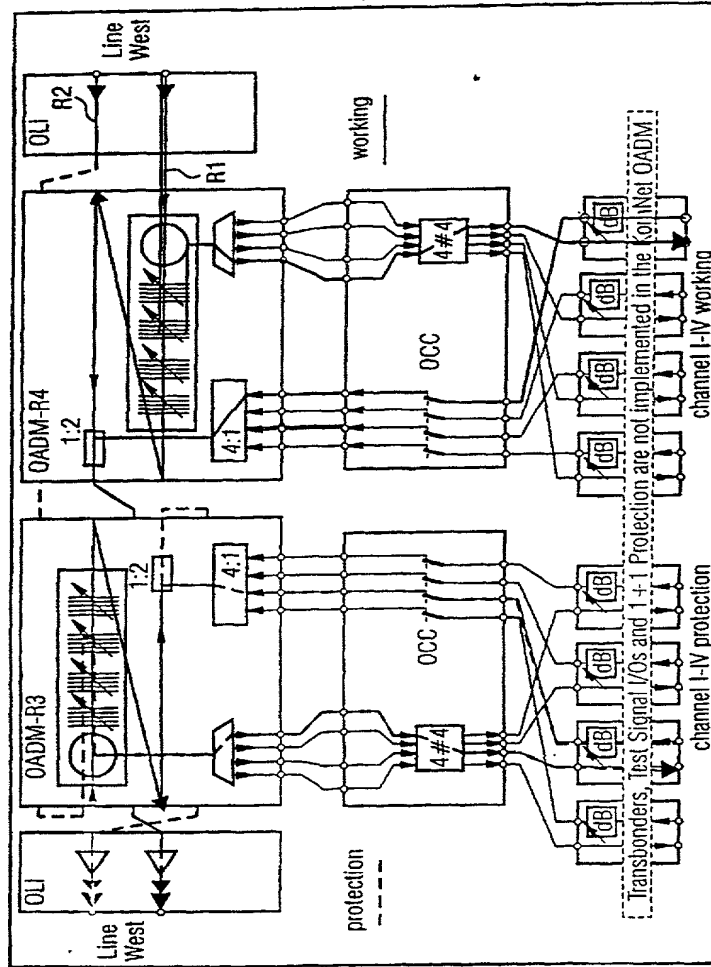


FIG 4

Declaration and Power of Attorney For Patent Application

Erklärung Für Patentanmeldungen Mit Vollmacht

German Language Declaration

Als nachstehend benannter Erfinder erkläre ich hiermit an Eides Statt:

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Netzknoten mit optischen Add/Drop-Modulen

deren Beschreibung

(zutreffendes ankreuzen)

☐ hier beigefügt ist.

☒ am 08.02.2000 als

PCT internationale Anmeldung

PCT Anmeldungsnummer PCT/DE00/00371

eingereicht wurde und am _____

abgeändert wurde (falls tatsächlich abgeändert).

Ich bestätige hiermit, dass ich den Inhalt der obigen Patentanmeldung einschliesslich der Ansprüche durchgesehen und verstanden habe, die eventuell durch einen Zusatzantrag wie oben erwähnt abgeändert wurde.

Ich erkenne meine Pflicht zur Offenbarung irgendwelcher Informationen, die für die Prüfung der vorliegenden Anmeldung in Einklang mit Absatz 37, Bundesgesetzbuch, Paragraph 1.56(a) von Wichtigkeit sind, an.

Ich beanspruche hiermit ausländische Prioritätsvorteile gemäss Abschnitt 35 der Zivilprozessordnung der Vereinigten Staaten, Paragraph 119 aller unten angegebenen Auslandsanmeldungen für ein Patent oder eine Erfindersurkunde, und habe auch alle Auslandsanmeldungen für ein Patent oder eine Erfindersurkunde nachstehend gekennzeichnet, die ein Anmeldedatum haben, das vor dem Anmeldedatum der Anmeldung liegt, für die Priorität beansprucht wird.

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name,

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

Network nodes with optical add/drop modules

the specification of which

(check one)

☐ is attached hereto.

☒ was filed on 08.02.2000 as

PCT international application

PCT Application No. PCT/DE00/00371

and was amended on _____

(if applicable)

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, §1.56(a).

I hereby claim foreign priority benefits under Title 35, United States Code, §119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

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Prior foreign applications
Priorität beansprucht

Priority Claimed

19906862.3

DE

18.02.1999

☒

☐

(Number)
(Nummer)

(Country)
(Land)

(Day Month Year Filed)
(Tag Monat Jahr eingereicht)

Yes
Ja

No
Nein

(Number)
(Nummer)

(Country)
(Land)

(Day Month Year Filed)
(Tag Monat Jahr eingereicht)

☐
Yes
Ja

☐
No
Nein

(Number)
(Nummer)

(Country)
(Land)

(Day Month Year Filed)
(Tag Monat Jahr eingereicht)

☐
Yes
Ja

☐
No
Nein

Ich beanspruche hiermit gemäss Absatz 35 der Zivilprozessordnung der Vereinigten Staaten, Paragraph 120, den Vorzug aller unten aufgeführten Anmeldungen und falls der Gegenstand aus jedem Anspruch dieser Anmeldung nicht in einer früheren amerikanischen Patentanmeldung laut dem ersten Paragraphen des Absatzes 35 der Zivilprozessordnung der Vereinigten Staaten, Paragraph 122 offenbart ist, erkenne ich gemäss Absatz 37, Bundesgesetzbuch, Paragraph 1.56(a) meine Pflicht zur Offenbarung von Informationen an, die zwischen dem Anmeldedatum der früheren Anmeldung und dem nationalen oder PCT internationalen Anmeldedatum dieser Anmeldung bekannt geworden sind.

I hereby claim the benefit under Title 35, United States Code. §120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, §122, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, §1.56(a) which occurred between the filing date of the prior application and the national or PCT international filing date of this application.

PCT/DE00/00371
(Application Serial No.)
(Anmeldeseriennummer)

08.02.2000
(Filing Date D, M, Y)
(Anmeldedatum T, M, J)

anhängig
(Status)
(patentiert, anhängig,
aufgegeben)

pending
(Status)
(patented, pending,
abandoned)

(Application Serial No.)
(Anmeldeseriennummer)

(Filing Date D,M,Y)
(Anmeldedatum T, M; J)

(Status)
(patentiert, anhängig,
aufgeben)

(Status)
(patented, pending,
abandoned)

Ich erkläre hiermit, dass alle von mir in der vorliegenden Erklärung gemachten Angaben nach meinem besten Wissen und Gewissen der vollen Wahrheit entsprechen, und dass ich diese eidesstattliche Erklärung in Kenntnis dessen abgebe, dass wissentlich und vorsätzlich falsche Angaben gemäss Paragraph 1001, Absatz 18 der Zivilprozessordnung der Vereinigten Staaten von Amerika mit Geldstrafe belegt und/oder Gefängnis bestraft werden können, und dass derartig wissentlich und vorsätzlich falsche Angaben die Gültigkeit der vorliegenden Patentanmeldung oder eines darauf erteilten Patentes gefährden können.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true, and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

German Language Declaration

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<i>Patrick Leisching</i>	<i>27.6.01</i>		
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Staatsangehörigkeit		Citizenship	
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(Supply similar information and signature for third and subsequent joint inventors).

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Unterschrift des Erfinders <i>[Signature]</i>	Datum <i>July 13th, 2001</i>	Inventor's signature <i>[Signature]</i>	Date <i>July 13th, 2001</i>
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Staatsangehörigkeit DE		Citizenship DE	
Postanschrift 6503 N Military Trail #4100		Post Office Address 6503 N Military Trail #4100	
Boca Raton, FI 33496 UNITED STATES OF AMERICA		Boca Raton, FI 33496 UNITED STATES OF AMERICA	
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Unterschrift des Erfinders	Datum	Inventor's signature	Date
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Staatsangehörigkeit		Citizenship	
Postanschrift		Post Office Address	
Voller Name des fünften Miterfinders:		Full name of fifth joint inventor:	
Unterschrift des Erfinders	Datum	Inventor's signature	Date
Wohnsitz		Residence	
Staatsangehörigkeit		Citizenship	
Postanschrift		Post Office Address	
Voller Name des sechsten Miterfinders:		Full name of sixth joint inventor:	
Unterschrift des Erfinders	Datum	Inventor's signature	Date
Wohnsitz		Residence	
Staatsangehörigkeit		Citizenship	
Postanschrift		Post Office Address	

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(Supply similar information and signature for third and subsequent joint inventors).